

A NEW CAVERNICOLOUS *SPELOBIA* SPULER
(DIPTERA: SPHAEROCERIDAE: LIMOSININAE) FROM THE
EASTERN UNITED STATES

S. A. MARSHALL AND W. K. REEVES

(SAM) Department of Environmental Biology, University of Guelph, Guelph, Ontario, N1G 2W1, Canada (e-mail: smarshal@evb.uoguelph.ca); (WKR) Department of Entomology, 114 Long Hall, Clemson University, Clemson, SC 29634, U.S.A.

Abstract.—*Spelobia pickeringi* Marshall, new species, a facultative cavernicolous limosinine sphaerocerid, is described from the eastern United States. It was collected in Santee Cave, South Carolina, and in epigeal Malaise and mushroom-baited traps in Georgia and Maryland. Based on a subsample of 727 adult flies, the Santee Cave population had a 1:1 sex ratio. White-eyed mutants and red eyed flies were present in a 1:3 ratio (white to red eyes) in Santee Cave.

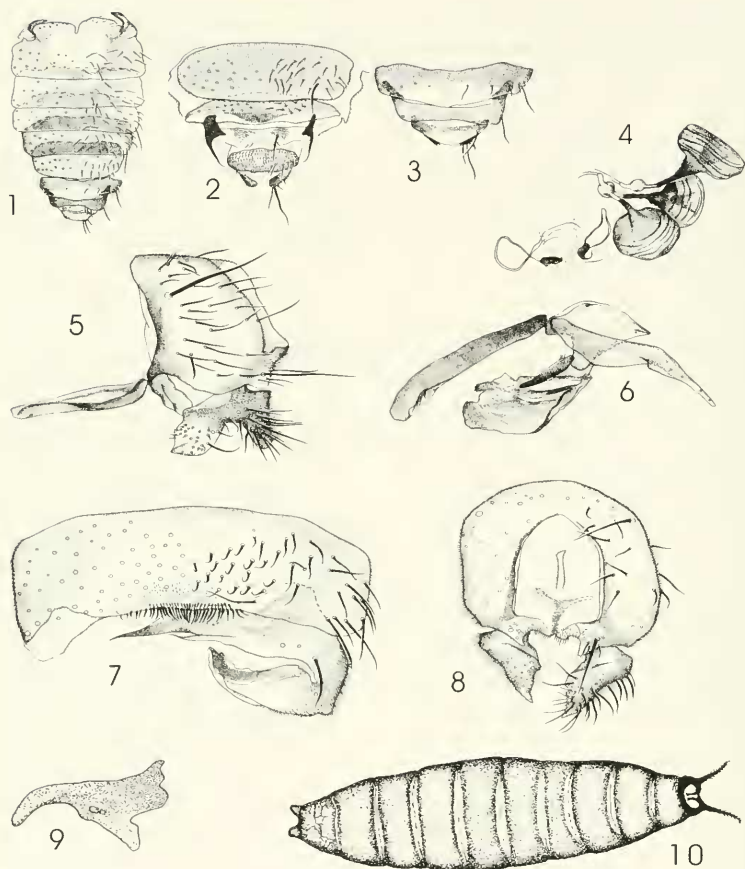
Key Words: caves, Diptera, Sphaeroceridae, *Spelobia*, guano, ecology

The genus *Spelobia* Spuler is one of the most common and speciose genera of Sphaeroceridae, and several of the 41 North American *Spelobia* species are regularly encountered in a variety of habitats including caves and mammal burrows. The genus is well documented in North America, and is generally well represented in collections. The new species described here was first collected as a single male in a mushroom-baited trap in South Carolina in 1989. Efforts to find additional specimens were unsuccessful, and it was surmised on the basis of its very small eyes that the species lived either in mammal burrows or caves. Dr. John Pickering (University of Georgia) took many more specimens, of both sexes, in Malaise traps in Georgia and Maryland during a biodiversity study in 1992. Repeated Malaise trap collections prompted the tentative conclusion that this small-eyed species inhabited ephemeral habitats such as mammal burrows, because hypogean species in stable habitats such as caves are unlikely to make regular dispersal flights. Oth-

er mammal-burrow specialists in the genus *Spelobia*, such as *S. lucifuga* Spuler, have been regularly taken in Malaise traps, while superficially similar cave-inhabiting species such as *Spelobia tenebrarum* (Aldrich) are never caught in surface traps. The new species described here is an exception to this generalization, as it was found breeding in caves in South Carolina in 1999. It is also of special interest because it is a cavernicolous species outside the clade that includes all previously described Nearctic cave and mammal-burrow *Spelobia* (Marshall 1985).

Spelobia pickeringi
Marshall, new species
(Figs. 1–10)

Diagnosis.—*Spelobia pickeringi* is easily distinguished from other eastern North American sphaerocerids by its unusual combination of very small eyes, equal interfrontal bristles, and a proximal postero-dorsal mid tibial bristle. In Marshall's 1985 key to North American *Spelobia* it keys to *S. frustrilabris* Marshall, a species with



Figs. 1-10. *Spelobia pickeringi*. 1, Male abdomen, dorsal. 2, Female terminalia, ventral. 3, Female terminalia, dorsal. 4, Spermathecae and associated vaginal sclerites. 5, Male terminalia, left lateral. 6, Aedeagus and associated sclerites. 7, Male sternites 5-7. 8, Male terminalia, posterior. 9, Mandible. 10, Puparium.

much larger eyes (eye height $3\times$ genal height) and a very different surstylus.

Description.—Adult: Length 2.2–2.6 mm; light brown, face and gena yellow brown.

Head: Interfrontal plate subequal in height and width, width $0.4\times$ interfrontal width, bordered by 3 equal interfrontal bris-

gles and 2 setulae along anterior margin. Lunule triangular, face concave-carinate. Gena with a long anterior bristle and 2–3 loose rows of marginal bristles; eye height $1.1\text{--}1.3\times$ genal height.

Thorax: Dorsocentral bristles in 2 large pairs, posterior pair slightly longer and subequal to scutellar length. Acrostichal setulae

small, in 6 rows between anterior dorsocentral bristles, prescutellar pair twice as long as others. Scutellum bluntly triangular, as long as wide. Katepisternum with posterodorsal bristles reaching half way to wing base, most specimens also with a minute anterodorsal bristle. Mid tibia with paired anterodorsal-posterodorsal bristles both proximally and distally, an additional smaller bristle present above each anterodorsal bristle. Tarsomere one of mid leg $0.5-0.6 \times$ tibial length. Wing length 1.7–1.8 mm, width $0.4 \times$ length, membrane brownish. Alula narrow, width equal to length of crossvein dm-cu. Second costal sector 1.2–1.4 \times length of third; R_{4+5} straight. Halter brown, apex of knob and stem pale.

Abdomen: Syntergite 1+2 almost twice as long as tergite 3, with a large anteromedial pale area (Fig. 1). Pleural membrane bare on segments 1–2, short-setulose on 3–5.

Male abdomen: Posteromedial comb of sternite 5 comprising 2 long rows of very small, flat setae (Fig. 7). Epandrium with a long dorsolateral bristle, otherwise with only sparse, short bristles. Cercus setulose, with one long bristle. Surstylus setulose on posterior $\frac{3}{4}$, anterior part with a few short bristles only. Unlike all other members of *Spelobia* s.s., surstylus (Figs. 5, 8) without stout ventral bristles but with flat, truncate, bare process posteroventrally at normal position of stout bristle. Basiphallus with a short, sharply pointed epiphallus, postgonite broad basally, narrow and tapered distally (Fig. 6). Female abdomen: Tergite 8 darkly pigmented dorsally. Tergite 10 broad, bare, with two very widely separated bristles (Fig. 3). Cercus very short, almost transverse, with long apical bristles. Sternite 7 posteromedially convex and setulose; sternite 8 small, depressed medially and convex on each side, each convex part setulose and with a long bristle (Fig. 2). Spermathecae large, tire-shaped, sclerotized parts of ducts short. Internal vaginal sclerotization including two small, dark pieces

and thin rings ("spectacles-shaped sclerite") (Fig. 4).

Egg: Length 0.6–0.7 mm, width 0.1 mm; tan brown, slightly curved, ends rounded, dorsal surface arched, ventral surface flattened, with reticulations on chorion; flap-like membranes extend from lateral margins.

Puparium: Length 2.8–3.1 mm, anterior width 0.1–0.3 mm, posterior width 0.1–0.3 mm; color brown, respiratory horns black, cylindrical, nearly straight; ends rounded (Fig. 10).

Cephalopharyngeal skeleton (third instar): Length from posterior tips of dorsal cornua to anterior tips of mouth hooks 0.3–0.4 mm, width at the widest point between dorsal cornua 0.04 mm; heavily sclerotized, opaque, dorsal cornua with partially sclerotized projecting sinuses. Mandibular hooks 0.08 mm long, 0.04 mm wide; sclerotized, separate, lacking accessory teeth (Fig. 9).

Type material.—Holotype: United States, South Carolina, Barnwell Co., near Barnwell State Park, mushroom-baited traps in oak forest, 10–18.iv.1989, S. A. Marshall (1 ♂). Paratypes: United States, Georgia, Clarke Co., $33^{\circ}54'N$, $83^{\circ}16'W$: 22–29.iv.1992, J. Pickering 62 (1 ♀); 03–10.vi.1992, J. Pickering 109 (4 ♂, 3 ♀); 15–22.vi.1992, J. Pickering 143 (1 ♂, 3 ♀); 10–17.vi.1992, J. Pickering 113 (4 ♀); 15–22.vii.1992, J. Pickering 142 (4 ♂, 3 ♀); 12–19.viii.1992, J. Pickering 164 (4 ♂, 3 ♀). Maryland, Pr. Georges Co., $39^{\circ}03'N$, $76^{\circ}47'W$, 20–27.vii.1992, J. Pickering 263 (4 ♂, 3 ♀). South Carolina, Orangeburg Co., Santee Caves $33^{\circ}29'N$, $80^{\circ}28'W$, 17.viii.1999, W. Reeves (8 ♂, 9 ♀); 20.x.1999, W. Reeves (4 ♂, 2 ♀).

The holotype and paratypes are in the University of Guelph Insect Collection, Department of Environmental Biology, University of Guelph. Several thousand non-type specimens are deposited in other museums, including the Natural History Museum of the University of Georgia. All specimens collected by J. Pickering were taken in Malaise traps.

Etymology.—This species is named after Dr. John Pickering, who collected the first long series.

Comments.—Although the surstylus of *Spelobia pickeringi* is strikingly different from any other *Spelobia s.s.*, this species is probably closely related to *Spelobia frustrilabris*, a species with similar midleg chaetotaxy (with a proximal posterodorsal bristle), male sternite 5, and spermathecae. It is easily separated from *S. frustrilabris* by its small eyes and its unusual male genitalia.

BIOLOGY OF *SPELOBIA PICKERINGI* IN
SANTEE CAVE, SOUTH CAROLINA

Santee Cave is a coastal plain limestone cave in Santee State Park, Orangeburg County, South Carolina. The largest known chamber in the cave houses a maternity colony of *Myotis austroriparius* (Rhoads) (Vespertilionidae). A two-meter guano pile below the bat colony appears to be the primary energy source for the terrestrial cave community. Reeves (2001) reported *S. pickeringi* (as *Spelobia* sp.) and 26 other invertebrate species on the guano pile. Five of these were guanophilic dipterans, including *Emmersonomyia socialis* (Stein) (Anthomyiidae), *Megaselia scalaris* (Loew), *Megaselia spelunciphila* Disney (Phoridae), *Clogmia albipunctatus* (Williston) (Psychodidae), and *Spelobia pickeringi*. Larvae and pupae of *S. pickeringi* live in the moist fresh guano and the older dry guano. Adults were present on the guano, walls, and floor of the chamber. They walk on the guano but were not seen flying in the cave, even when disturbed. *Spelobia pickeringi* flew toward lights when released in the laboratory, and like, other cavernicolous Diptera (e.g., *Megaselia cavernicola* (Brues)), are positively phototactic under laboratory conditions (Reeves and Disney 1999).

Spelobia pickeringi was collected with pitfall traps or forceps. Two plastic pitfall traps with an entrance diameter of 7 cm and a volume of 250 ml were installed below the bat colony and in the chamber floor. Both traps were buried flush with the sub-

strate and filled with 200 ml of ethylene glycol. The trap in the guano pile was partially shielded from falling guano with a cardboard sheet (0.3 m long, 0.15 m wide) placed approximately 9 cm above the trap opening. Traps were installed on 6 October 1999 and retrieved on 20 October 1999. An estimated five to eight thousand *S. pickeringi* were collected in the traps. *Spelobia pickeringi* might have been attracted to the ethylene glycol, but it also appeared to be the most numerous arthropod in the cave.

We used a subsample of 727 specimens to determine sex and eye-color ratio. There were 340 males to 387 females in Santee Cave and a Chi-square test supported a 1:1 ratio ($P < 0.05$). The sex ratio of other cavernicolous dipterans is unknown. *Spelobia pickeringi* in Santee Cave has red, pink or white eyes. The ommatidia of pink-eyed flies were a mix of red and white, indicating partial dominance of the red-eyed gene, but it was not possible to differentiate eye color between some red and pink-eyed flies. The population of *S. pickeringi* in Santee Cave was expected to have no eye-color selection pressure. In our subsample there were 196 white eyed to 531 colored-eyed flies and a Chi-square test supported a 1:3 ratio of white eyed flies to colored eyes in both sexes ($P < 0.05$). The 1 to 3 ratio is expected for a single gene heterozygous recessive trait and indicates that there was no selection pressure on eye color and suggests that eye color is unimportant in total darkness. Eye color does not appear to be sex linked.

Gravid females of *S. pickeringi* had 15 or 16 mature eggs. Eggs had short membranous flaps along their lateral margins. Oviposition was not observed, but the flap might adhere eggs to the substrate or keep them floating on liquid media.

Internal parasites were not detected in the preserved specimens. However deutonymphs of the mite *Histiostoma* sp. (Acari: Histiostomatidae) were attached to the intersegmental thoracic membranes of some flies. This is a saprophytic mite and the phoretic stage does not feed on the host fly.

The mites could be detrimental if they hinder host movement or increase predation. On the guano pile the spiders *Eidmannella pallida* (Emerton), *Gauceolmus augustinus* Keyserling (Araneae: Nesticidae), and *Azilia affinis* Chamberlin (Araneae: Tetragnathidae) fed on *S. pickeringi*.

ACKNOWLEDGMENTS

We thank W. Wills for field assistance, R. Langstaff and M. Reeves for illustrations, and H. Klompen for identifying *Histiostoma* near *piloseta*. Collections in Santee Cave were conducted under South Car-

olina State Parks Research Permit Number N-2-1999.

LITERATURE CITED

- Marshall, S. A. 1985. A revision of the genus *Spelobia* Spuler (Diptera: Sphaeroceridae) in North America and Mexico. *Transactions of the American Entomological Society* 111: 1-101.
- Reeves, W. K. 2001. Invertebrate and slime mold cavernicoles of Santee Cave, South Carolina, USA. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 151: 81-85.
- Reeves, W. K. and R. H. L. Disney. 1999. Taxonomy and biology of two Nearctic species of cavernicolous scuttle flies [Diptera: Phoridae]. *Studia Dipterologica* 6: 207-218.